Mass Casualty Response of a Modern Deployed Head and Neck Surgical Team

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Background: The battlefields of the Global War on Terror have created unique demands on deployed surgical teams. Modern high-energy fragmentation devices often inflict complex head and neck injuries. This series analyzes the role of the head and neck surgical team during 3 separate single explosive events that led to civilian multiple casualty incidents (MCIs) treated at a military theater hospital in Iraq from February to April 2007.

Methods: All MCIs occurring between February and April 2008 with triage and treatment at the 332nd Air Force Theater Hospital in Balad, Iraq, were identified and reviewed. Injury Severity Score, admission injury pattern, length of hospital stay, head and neck procedures, non–head and neck procedures, and clinical duties performed by the otolaryngology surgeon were recorded and analyzed.

Results: Three MCIs occurring during the period of February to April 2008 were reviewed and described as incidents A, B, and C. A total of 50 patients were involved. Eighteen patients (36%) were treated for head and neck trauma. The average ISS for the non–head and neck trauma group was 15.8 (range, 1–43), whereas the head and neck trauma group average ISS was 23.6 (range, 2–75) ($P < 0.06$). The most commonly performed head and neck procedures included repair of facial lacerations, maxillomandibular fixation, and operative reduction internal fixation of facial fractures. The head and neck surgeon also performed airway triage and assisted with procedures performed by other specialties.

Conclusions: By reviewing 3 MCIs and the operative log of the involved otolaryngologist, this review illustrates how the otolaryngologist's clinical knowledge base and surgical domain allow this specialist to uniquely contribute in response to a mass casualty incident.

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Propper and colleagues[1] recently reported the surgical response to multiple casualty incidents (MCIs) at the 332nd Expeditionary Medical Group/Air Force Theater Hospital (AFTH) at Balad Air Base, Iraq. Their study described the overall anatomic injury pattern encountered in single explosive events as well as the potential resource utilization and surgical surge during the first 72 hours after such events. Additionally, novel parallel operating strategies were described, identifying the important role of a wide range of surgical subspecialists required to respond to such catastrophes. Civilian and military reports demonstrate that a surgical team capable of performing maxillofacial surgery is a critical piece of managing trauma; however, the literature lacks an adequate description of the head and neck team's role in MCIs.[2,3]

During operations in the Iraqi and Afghanistan theaters of war, penetrating blast injury is the most common mechanism resulting from improvised explosive devices. This mechanism causes a range of injuries including penetrating soft tissue, thermal injury, and blast.[4,5] Improvised explosive devices are difficult to detect, portable and relatively inexpensive to create, and often designed to result in MCIs.[5] As such, these types of explosive devices are the main terrorist threat likely to be used in a public forum resulting in an MCI for area medical systems and hospitals.

Recent Israeli trauma research has yielded valuable information on MCIs. For instance, computer simulation based on analysis of 12 urban terrorist bombings has helped to quantify necessary hospital staffing and resource requirements after bombing attacks in Israel.[6] The Israeli data further serve to delineate expected wound patterns following publicly detonated devices. Often victims arrive quickly to the closest hospital, and a significant number of patients will arrive with Injury Severity Scores (ISS) of 16 or greater, which is a marker for critical injury.[3] Based on the Israeli experience, surgical subspecialists will be involved in a third of operations for victims of single explosive events.[7] Propper and colleagues[1] described approximately 4 procedures per operation per casualty after a single explosive event, which often requires parallel operating strategy to include surgical subspecialist procedures, coordinated with the trauma surgeon. Additionally, subspecialty surgical care is often required for more than 24 hours after the primary patient influx to manage those injury patterns that require repeat or delayed operation.

Unfortunately, the threat of future single explosive attacks remains real in both the military and civilian setting. Despite increasing amounts of information obtained from managing MCIs in civilian and wartime setting, no accounts to date provide details on

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TABLE 1. Injury Severity and Distribution

	n (%)	Male	Female	Average ISS	Length of Stay, d	Traumatic Brain Injury
Non–head and neck	32 (64)	32	0	15.8	5.8	4 (12.5%)
Head and neck	18 (36)	17	1	18.6	7.7	8 (44%)

the patterns of injuries managed by the head and neck surgical team following these events. The objective of this report was to describe the role of the head and neck surgeon in responding to 3 consecutive MCIs resulting from single explosive events.

MATERIALS AND METHODS

Institutional review board approval was obtained for this retrospective study of prospectively collected data. All information for this project was on local national patients and was deidentified before analysis.

All patients (Iraqi civilians, police, or army) evacuated to and seen at the 332nd AFTH after 3 consecutive MCIs from February 1 to April 30, 2008, are included in this study. This echelon III facility serves as the central air evacuation point for all US service personnel injured in Operation Iraqi Freedom and at the time was the only surgical facility for the treatment of significant civilian injuries. Since September 2004, this facility has been comparable to an American College of Surgeons level I trauma center in the United States.

These multiple casualties incidents are labeled A, B, and C. Any patient who was involved in the incident but not treated at the AFTH was excluded, as their information was not available for review. Any patient treated at the AFTH during these dates but not involved in the mass casualty was also excluded. Data from each indivual event were examined (intraevent analysis). Comparison of the 3 separate events was performed (interevent analysis). The following data points were recorded during the first 72 hours for each admissoin: ISS, admission injury patterns, length of hospital stay, head and neck procedures, and non–head and neck procedures. Additionally, the operative log of the involved otolaryngologist (R.L.E.) was examined to review procedures that were performed. Any operation as previously defined by Propper et al[1] as "any single trip to the operating room which required a general anesthetic and full operating room set up" was included in this study. Procedures as defined by Propper et al were "any interventions performed during a single operation." In this study, procedures also included those performed by the head and neck team outside the operating room (eg, a facial laceration closure under local anesthesia in the emergency room). Head and neck trauma from the 3 separate incidents was managed by the same head and neck surgical teams.

Additionally, the operative log and clinical experience were reviewed to describe the typical clinical duties performed by the head and neck surgeon in MCIs. The null hypothesis described the ISS, length of stay, and procedures performed as being no different between head and neck and general trauma groups. Statistical significance was established as $P < 0.05$.

TABLE 2. Head and Neck Cases per MCI

MCI	Head and Neck	No. Operations	No. Procedures	Procedures/ Operation
A	6	7	20	2.9
B	4	4	14	3.5
C	4	5	9	1.8

RESULTS

Three MCIs occurred during the period February 1 to April 30, 2008, and were reviewed and described as incidents A, B, and C. Incident A involved 21 patients, incident B involved 19 patients, and incident C involved 10 patients. Incidents A, B, and C were attributed to a car bomb, an explosive vest, and a bus bomb, respectively.

A total of 50 casualties were triaged and treated from these 3 incidents. Thirty-two (64%) patients did not sustain head and neck trauma, whereas 18 patients (36%) were treated for head and neck trauma based on initial admission injury pattern descriptions. All patients treated were male except for 1 female patient in the head and neck trauma group. The overall average ISS was 18.6 across both groups. The average ISS for the non–head and neck trauma group was 15.8 (range 1–43), whereas the head and neck trauma group average ISS was 23.6 (range, 2–75) ($P < 0.06$). The length of hospital stay was 6.5 days overall and similar across both groups: 5.8 days for non–head and neck trauma and 7.7 days for head and neck trauma ($P < 0.34$) (Table 1).

Traumatic brain injuries occurred in 12.5% (4/32) of patients in the non–head and neck trauma group compared with 44% (8/18) of patients in the head and neck trauma group ($P < 0.01$) (Table 1). Head and neck injuries were described only in the head and neck trauma group. On average, 3 head and neck injuries per patient were described in the head and neck trauma group (range, 1–14). These injuries include soft-tissue trauma (lacerations, burns), facial fractures (maxilla, mandible, frontal sinus), and miscellaneous injuries such as a parotid duct injury.

Based on review of the operative log, 6 patients from incident A required a total of 7 head and neck operations, involving

FIGURE 1. Parallel operating during MCI at Balad Air Base, Iraq.

TABLE 3. Procedures Performed

MCI	Soft-Tissue Repair	MMF	ORIF	I&D	Tracheostomy	Cricothyroid Closure	Facial Nerve Repair	Salivary Repair
A	10	3	3	2	0	0	0	1
B	2	1	2	2	3	2	1	0
C	5	0	1	3	0	0	0	0

MMF indicates maxillomandibular fixation; ORIF, open reduction–internal fixation; I&D, incision and drainage.

20 procedures (average, 2.9 procedures per operation) (Table 2). Four operations were performed on the first day of the incident with 1 operation each subsequent day. Procedures included 10 complex soft-tissue repair/closures (50%), 3 placements of maxillomandibular fixation (15%), 3 open reduction–internal fixation of severe mandible fractures (15%) (Fig. 1), 2 irrigation and debridements of local wounds (10%), 1 open reduction–internal fixation of a maxillofacial fracture (5%), and 1 repair of a transected Stensen duct (5%) (Table 3).

Four patients from incident B required a total of 4 head and neck operations, involving 14 procedures (average, 3.5 procedures per operation) (Table 2). All operations were performed on the first and second days of the incident. Procedures included 3 tracheotomies (21.4%), 2 cricothyrotomy closures (14.3%), 2 complex facial soft-tissue repair/closures (14.3%), 2 neck exploration (14.3%) and 2 open reduction–internal fixations of a facial fracture (14.3%), 1 facial nerve repair with parotidectomy for exposure, and 1 maxillomandibular fixation (7.1%) (Table 3).

Four patients from incident C required a total of 5 head and neck operations, involving 9 procedures (average, 1.8 procedures per operation) (Table 2). All operations were performed on the first day of the incident. Five complex facial soft-tissue repair/closures (56%), 3 irrigation and debridements of local wounds (33%), and 1 open reduction–internal fixation of a frontal sinus fracture (11%) were performed for this MCI population (Table 3).

Overall, the average number of procedures per operation was 2.7, which required liberal use of parallel operating strategy, defined as more than 1 surgical team operating on the same patient simultaneously. Additionally, to accomplish the surge of operative cases in a safe and expeditious manner, it was necessary throughout each event to expand operating room capacity accommodating more than 1 patient simultaneously (Fig. 2). In addition to the above procedures, the involved head and neck surgeon assisted in other surgical procedures such as popliteal artery repair with reverse saphenous vein graft, repair of profunda femoral artery, extremity washouts, orthopedic trauma, and ophthalmologic trauma.

FIGURE 2. Complex mandible fracture after single explosive multiple casualty event.

DISCUSSION

The global war on terror has presented a different milieu to the involved head and neck surgeon. High-energy, high-velocity weapons experienced there inflict tremendous tissue destruction. Urban conflict additionally brings weaponry and fragmentation devices in close proximity to civilians as well as soldiers. This has produced escalating numbers of survivable yet complex head and neck injuries. In this study, more than a third of the patients identified in 3 separate MCIs sustained head and neck injuries. The most common injuries involved soft-tissue trauma. Assessment and management of these injuries with irrigation, judicious debridement, and primary closure comprised the majority of the head and neck surgical procedures.

Domestic bombings are not foreign to the United States. The largest vehicle bomb incident occurred in Oklahoma City in 1995. Description of the injury pattern sustained by survivors of this incident shows that soft-tissue injuries are the most common type of injury with these events.[8] Injuries involving the head and neck as well as the face may account for up to 48% and 45% of soft-tissue injuries, respectively. Facial fractures may account for more than a third of fractures and dislocations.

However, the head and neck surgeon's role in MCIs goes far beyond simple laceration management. Also included are advanced airway management, neck exploration, treatment of facial fractures, advanced airway management, neck exploration, management of salivary injury, facial nerve repair, and assistance with general trauma procedures.

Although facial fractures are rarely emergencies, single explosive events have the potential for severe facial fractures that may complicate the patient's airway. Having an experienced otolaryngologist available to secure the airway with advanced techniques may help to minimize the risk for acute airway compromise in the setting of severe head and neck trauma. This is illustrated by the 3 tracheotomies performed for patients from incident B who sustained injuries from an explosive vest device.

An otolaryngologist is uniquely equipped with clinical and surgical skills that are useful in MCIs. These skills include a detailed understanding of laryngeal, esophageal, and pharyngeal surgery, airway management, facial soft-tissue trauma, sinus trauma, and facial fracture management. Additionally, the head and neck surgeon is trained to consider subtle head and neck injuries such as facial nerve or parotid duct transection. The flexibility to operate alongside other trauma specialties in additional anatomic regions imparts greater value to the involved otolaryngologist. We therefore conclude that head and neck surgeons should be routinely utilized during military and civilian MCIs.

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